A COMPARATIVE STUDY OF SELECTED ANTHROPOMETRICAL, PHYSICAL AND PHYSIOLOGICAL VARIABLES OF DIFFERENT ZONE OF MALE AEROBIC GYMNASTS

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Synopsis

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TABLE OF CONTENT

CHAPTER-1 **Page no.**

INTRODUCTION **1-6**

a) Statement of the problem 7
b) Objective of the study 7
c) Delimitation 7-8
d) Hypothesis 8
e) Definition and explanation of the terms 8-10
f) Significance of the study 11

CHAPTER-II

REVIEW OF RELATED LITERATURE **12-17**

CHAPTER-III

METHODOLOGY

a) Selection of the subjects 18
b) Selection of variables 18-19
c) Criterion measures 19
d) Collection of data 19
e) Statistical technique 20

Bibliography **21-22**

ABSTRACT

The purpose of the study is to compare selected Anthropometrical (Standing Height Weight, Arm length, Leg length, Shoulder circumference, Chest circumference, Arm circumference, Thigh circumference), Physical (Speed, Arms & Shoulder Muscle power, Abdominal Muscular Power, Explosive Leg Strength, Trunk Flexibility, Side splits) and Physiological (Vital Capacity, Fat %, Resting Heart Rate) characteristics of Aerobics gymnasts of different zone. In this study 90 Aerobics Gymnasts was selected from two different zone (North zone-45 and East zone-45) Age between 14 to 21 years. The level of significance at 0.05 level. Z- test use for analysing the data. SPSS software will used for calculation and computation of data.

Keywords: Aerobic Gymnastics, Anthropometrical, Height, Weight, Length, Circumference, Physical, Speed, Muscle power, Explosive, Strength, Flexibility, splits, Physiological, Vital Capacity, Fat %, Heart Rate.

CHAPTER- I

Introduction

Gymnastics is the oldest sports in Olympic. It is a become a part of first modern Olympic. The International Gymnastics Federation is the governing body for Gymnastics worldwide. It is the oldest established international federation of an Olympic sport and has participated in the Olympic Games since their revival in 1896. The FIG governs eight sports: Gymnastics for All, Men's and Women's Artistic Gymnastics, Rhythmic Gymnastics, Trampoline - including Double Mini-trampoline and Tumbling -, Aerobics, Acrobatics, and Parkour. It counts more than 160 national member federations and has its headquarters in the Olympic Capital of Lausanne (SUI).

The history of gymnastics dates back thousands of years, with its roots deeply embedded in ancient civilizations. In ancient Greece, gymnastics was an integral part of education and training for soldiers. It was believed that a well-rounded individual should possess physical strength, mental discipline, and artistic expression. Gymnastics provided the perfect platform to develop these qualities.

As time passed, gymnastics evolved and spread to other cultures. The Romans embraced the sport and incorporated it into their military training. However, with the decline of the Roman Empire, gymnastics lost its popularity and went into a period of obscurity.

It was not until the 18th century that gymnastics experienced a revival. Johann Christoph Friedrich Guts Muths, a German educator, is often referred to as the "Grandfather of Gymnastics" for his significant contributions to the development of the sport. He emphasized the importance of physical exercise, balance, and coordination in his teachings.

In the 19th century, gymnastics gained even more recognition thanks to Friedrich Ludwig Jahn, another German educator. Jahn is known as the "Father of Modern Gymnastics" for his establishment of gymnastics clubs and introduction of various apparatus, such as the horizontal bar, parallel bars, and balance beam.

Aerobic gymnastics, also known as sport aerobics, is a dynamic and energetic discipline that combines elements of traditional aerobics, dance, and gymnastics. It is a competitive sport where athletes perform choreographed routines to music, showcasing their strength, flexibility, coordination, and cardiovascular endurance.

The seeds of Aerobics eventual fusion with Gymnastics were sown on October 30, 1993, when affiliated federations officially asked the FIG Executive Committee to introduce Aerobic as a discipline in the FIG competition programme. The following year, at the FIG Congress in Geneva (SUI), FIG President Yuri Titov (RUS) invited delegates to accept the setup of an Aerobic Sports Commission, as well as the organisation of a World Championships in 1995.

Things took off from there. On March 14, 1995, the first Judges' and Coaches' Course in Aerobic was held in Switzerland. In December of the same year, the first FIG Aerobic World Championships were held at the Stade de Coubertin in Paris. Competitors from Brazil dominated the competition, taking three of the four event titles, and seven other nations won medals.

In 1996, the FIG officially recognised Aerobic Gymnastics as a FIG discipline and it has continued to evolve as a sport in recent years. The discipline is especially popular in Asia, where it is practiced by several university teams.

Aerobic gymnastics, also known as sport aerobics. Gymnasts compete in 7 categories (Individual men and women, Mix pairs, Trios, Groups, Aerobic dance, Aerobic steps). Gymnast perform up to 10 difficult elements in each routine, including (Traditional Aerobics steps, Dynamic strength elements, Static and strength holds, Jumps and leaps).

The benefits of gymnastics exercises are enormous as it mainly develops various component of Physical fitness such as strength, flexibility, agility, co-ordination, balance, grace, good posture, and ability to respond. Moreover, the gymnast's body is continuously changed its direction and pace. In this process, the gymnast gain orientation and the interaction of inner and outer forces which enhance coordination skills and concentration. Aerobic Gymnastics requires mainly anaerobic energy for competitive performance. But also, it is very important to get the high capacity of aerobic power for performing the perfect execution.

Movements such as jumping, climbing, hanging, dangling, rolling, and 'flying' - which come naturally to most participants - are gymnastic elements that aid in the acquisition of cognitive and motor skills. They assimilate the so-called 'crossover' across-the-body axis and support the collaboration of both sides of the brain. The left side is liable for analytic thinking, language, and logical processes while the other side influences holistic thinking, spatial orientation, creativity, emotions, and visual imagination. Above all, however, the children achieve an awareness of their body in a fundamental way which is not found in other sport. - (Michael Strauss).

Aerobic gymnastics is a part of competitive Gymnastics that is recognized by the International Gymnastics Federation (FIG). At international level sports Aerobic came under the banner of FIG in the year1994. Aerobics gymnastics involves the performance of routines by individuals, pairs, trios, or groups up to six people, emphasizing strength, flexibility, and aerobic fitness rather than acrobatic or balance skills. According to its performance structure, it is characterized as an aesthetic-technical discipline with energy coverage from the anaerobic glycolytic system. Previous investigation of aerobic gymnastics routine performance (Kyseloyicoya & Danieloya, 2012) revealed that the values document clear anaerobic dominance and anaerobic energy metabolism. However, Kyseloyicoya et al. (2016) also noted, that it is rather complicated to assess the physiological and energetic demands during exercises of relatively short duration, changing intensity, and types of muscle activation.

The Gymnastics Federation of India came to existence in 17th February 1951. The first meeting of the Federation was held at the National Sports club, Mumbai. The Federation started

competition which was held in only one discipline i.e., Artistic Gymnastics. In the course of time, the Federation has now 28 affiliated units and six disciplines, namely Artistic Gymnastics, Rhythmic Gymnastics, Sports aerobics, Acrobatics, Trampoline and General Gymnastics. The Federation has got affiliation from the Federation of International Gymnastics (FIG) in the year 1952. It is also an affiliated unit of the Common wealth Gymnastics Confederation (CGC), Asian Gymnastics Union (AUG), and Indian Olympic Association (IOA). The Federation is registered under the societies Registration act, 1957.

Anthropometrics in aerobic gymnastics is a field of study that focuses on the measurement and analysis of human body dimensions, proportions, and composition in relation to the sport. It plays a significant role in understanding how an athlete's physical characteristics influence their performance, training, and competitive potential. By assessing various anthropometric variables, coaches, trainers, and sports scientists can tailor training programs, identify strengths and weaknesses, and optimize the performance of aerobic gymnasts.

Anthropometrics in aerobic gymnastics provide a comprehensive understanding of an athlete's physical characteristics and their impact on performance. By analysing and utilizing these measurements, coaches and trainers can make informed decisions regarding training methods, technique refinement, injury prevention, and talent identification. It is important to note that while anthropometrics is valuable, success in aerobic gymnastics is also influenced by factors such as skill development, mental preparation, and artistic expression, which interact with the physical aspects to create a complete athlete.

In aerobic gymnastics, as well as in other sport disciplines, there is a constant demand for an ever-increasing performance level. The level of physical fitness is dependent on the innate predispositions and environmental factors, such as, for example, primarily training. It is also believed that in order to achieve a high degree of complex motor performance, the training needs to begin in early childhood as it plays an important role in the development of motor skills (Sawczyn et al., 2000; Kochanowitz et al., 2010).

The success of each gymnast is highly dependent on the level of their motor abilities (Jemni et al., 2006). Therefore, a systematic examination of training effects is needed. The

evaluation of the motor skill levels requires the use of objective, quantitative and qualitative criteria. There are many techniques available for measuring motor abilities and the general level of motor fitness. They serve not only to assess the current level of motor abilities, but also to monitor improvement during the process of training (motor development). However, it is necessary to continually monitor the training effects of each athlete to allow the individualization of training loads (Kochanowitz et al., 2006; Ortega et al., 2008; Zaporozhanov et al., 2012).

Aerobics Gymnasts are required to demonstrate complex high-intensity movements to music, involving many gymnastics and dance-based skills, difficult elements, and acrobatic moves, displaying the discipline's variety and creativity. Routines are evaluated by judges who consider three different aspects: difficulty, artistic value, and execution (Raiola et al., 2012; FIG, 2017).

Physical activity during the period of growth results in significant changes in anaerobic strength and aerobic capacity. It has also a beneficial impact on aerobic and muscular strength, coordination, and muscular endurance (Ortega et al., 2008).

There have been a few studies researching the effects of a long-term gymnastics training on both anthropometric and motor parameters (Tibenska et al., 2010; Zivcic et al., 2012; Mertashl et al., 2015; Mlsnova, 2016).

Regular gymnastics training contributes to the development of coordination, strength, muscular endurance, flexibility, and balance (Bencke et al., 2002; Werner et al., 2012).

Many authors (Gallahue et al., 2012; Piek et al., 2012) agree that early childhood is considered to the ideal age for the development of fundamental movement skills that become the basis for both skills needed for the daily life as well as specific movements needed for the participation in different sports and physical activities. Sports preparation, in general,

positively influences children's health in terms of physical fitness, and it also improves anthropometric measurements like body weight and body composition (Fisher et al., 2005).

Physiology in aerobic gymnastics refers to the study of the body's functions and systems in relation to the sport. It explores how the various physiological variables and processes impact an athlete's performance, training, and overall physical conditioning. Understanding the physiological aspects of aerobic gymnastics is crucial for optimizing training programs, enhancing endurance, improving cardiovascular fitness, and maximizing athletic potential.

Monitoring and assessing physiological variables in aerobic gymnastics enable coaches and trainers to individualize training programs, track progress, identify strengths and weaknesses, and make data-driven adjustments to optimize performance. However, it is important to consider that success in aerobic gymnastics is also influenced by skill development, technique, mental preparation, and artistic expression, all of which interact with the physiological aspects to create a complete athlete.

By understanding the physiological aspects of aerobic gymnastics, coaches, trainers, and athletes can develop targeted training programs, monitor progress, and make informed decisions to enhance performance and overall physical conditioning. However, it is important to acknowledge that success in aerobic gymnastics is also influenced by factors such as skill development, technique, mental preparation, and artistic expression, which interact with the physiological aspects to create a complete athlete.

According to Douda et al. (2008), important factors for the execution of gymnastics seem to be anthropometric characteristics, flexibility, aerobic capacity, and anaerobic power.

STATEMENT OF THE PROBLEM

The purpose of the study is to compare selected anthropometrical, physical, and Physiological characteristics of Aerobics gymnasts of different zone.

Objectives of the study

The objective of the study is to compare Aerobics Gymnasts different characteristics based on selected Anthropometric, Physical, and Physiological variables.

Delimitation

1. The study will be delimited to Male National Aerobic Gymnasts age between 14 to 21 years.
2. The study will be delimited to Two zone (North zone and East zone).
3. The study will be delimited to 90 Male National Aerobic Gymnasts (45 from North zone and 45 from East zone).
4. The study will be further delimited to following Anthropometrical, Physical, and Physiological variables:

A. Anthropometric Variables

- Standing Height
- Weight
- Arm length
- Leg length
- Shoulder circumference
- Chest circumference
- Arm circumference
- Thigh circumference

B. Physical Variable

- Speed
- Arms & Shoulder Muscle power
- Abdominal Muscular Power
- Explosive Leg Strength

- Trunk Flexibility
- Side splits

C. Physiological Variables

- Vital Capacity
- Fat %
- Resting Heart Rate

HYPOTHESIS

Based on experts' opinion, reviews from the available researches and scholar's understanding of the problem, it is hypothesized that:

1.There will be no significant difference between mean of Anthropometric variable of Aerobics Gymnasts of different Zone.

2. There will be no significant difference between mean of physical variable of Aerobics Gymnasts of different Zone.

3. There will be no significant difference between mean of physiological variable of Aerobics Gymnasts of different Zone.

DEFINITION AND EXPLANATION OF TERMS

Anthropometric:

Anthropometric is the science of measuring the human body and its parts. It is used as an aid to the study of human evaluation and variations. According to Philips and Harnak (2003) the measurement of the structure and proportion of the body is called anthropometry.

Aerobics Gymnastic:

Aerobic gymnastics is one of the gymnastics types that is recognized by the International Gymnastics Federation (FIG).

Vital Capacity:

Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inhalation. It is equal to the sum of inspiratory reserve volume, tidal volume, and expiratory reserve volume.

Physiology:

Physiology, refers to the study of normal functioning of the living structures.

Fat:

Fat is a concentrated source of energy – 1 gram of fat contains 9 calories.

Resting Heart Rate:

It is the number of times your heart beats per minute while at complete rest. It is an indicator of physical fitness as your resting heart rate will decrease as your heart becomes stronger with aerobic exercise training.

Standing Height:

It is the maximum height of the individual when standing erect on a horizontal surface with his head and face in Frankfort horizontal plane.

Weight:

Weight of the human body while wearing a minimum cloth, is known as body weight.

BMI:

BMI is a person's weight in kilograms (kg) divided by his or her height in meters squared.

Arm Length:

The straight length between the acromion point to tip of middle finger is known as arm length.

Leg Length:

It may be calculated by subtracting sitting height from standing height.

Shoulder circumference:

The Circular measurement of shoulders at the level of the midpoints of the right and left deltoid muscles.

Chest Circumference:

It is the circumference of chest at the level of the nipples in front, subscapular region at the back and is measured at the end of a normal expiration.

Upper -Arm Circumference:

The circular measurement of left upper-arm at the midpoint of humerus.

Thigh Circumference:

It is the circumference of the thigh at a mid-point of femur length.

Speed:

Speed is measured as the ratio of distance to the time in which the distance was covered.

Arms & Shoulder Muscle power:

The ability to perform maximum numbers of correct push-ups in 30 seconds.

Abdominal Muscular Power:

The ability to perform maximum numbers of correct bent-knee sit-ups in 30 seconds.

Explosive Leg Strength:

The ability to Perform horizontal jump as far as possible.

Trunk Flexibility:

The ability to flex or stretch the trunk and back muscles as far as possible in L sit position.

Significance of the study

1. The results of the study will helpful to the coaches, sports scientists, and physical educationists for talent identification of Aerobic Gymnasts based on Physical, Physiological and Anthropometrical characteristics.

2. The results will be helpful in development of Aerobics Gymnastics and will add some more knowledge in the existing literature pertaining to Anthropometrical, Physical and Physiological characteristics of the National Aerobics Gymnasts of different zone of India.

3. Study will also motivate and provide general Awareness about Aerobics Gymnastics to other players of non-participating state.

4. It will also give a specific guideline and direction to the coaches, trainers, and junior players in designing their training schedule based on Anthropometrical, Physical and Physiological characteristics of Aerobics Gymnasts.

5. Study will be helpful in development of Aerobics Gymnastics in other non-participating states in India.

CHAPTER II

REVIEW OF RELATED LITERATURE

Musaeva U.A. et al. (2023) conducted study of comparative assessments of physical development and composition of the body weight on women's who participated in Aerobics and rhythmic gymnastics. They selected 90 girls (aerobics=30, rhythmic=30, control group=30) from Republic of Uzbekistan. they measure 16 anthropometric indicators: 3 of them were total size, and partial size were determined by longitude, latitudinal ad girth indicators of body segment. Four skinfolds (under the scapula, upper iliac region, back of the leg and shoulder). Four diameters (shoulder, forearm, thighs, and lower legs). The composition of body weight was determined in percentage by the method of Heath-Carten 1989, universal method of somatotypology. After comparison they found that women who participated in sports have longer upper and lower limbs, they are also taller. Highest growth recorded in among athletes involved in rhythmic gymnastics, they also found lowest values of the circumference of the shoulder, fore arm and hip in female gymnast. Found broader shoulder in gymnast as comparison to control group. Significant difference found between control group and gymnast in Body length. case length, upper limbs length, lower limbs length, forearm length, brush length, calf length and circumference of shoulder, thigh, calf & shoulder width. Average thickness of skin-fat of aerobics gymnast 11.6, rhythmic gymnast 11.3, control group 15.5. control group found higher mass of fat component 27.3%. Aerobics gymnast have higher indicator of mesomorphism and actomorphism in relation to rhythmic gymnast at the 0.05 level of significanc

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Nusratovich et. al. (2022) conducted a study of Anthropometric and functional changes and their relationship after two years Aerobic Gymnastics training on 12 Junior Girls gymnast, age 13 to 17 years, where girls attended regular sports training (120 minutes- 5 times/week) for two years from 09/2003 to 12/2002. Data collected regularly, every 12 weeks. On Anthropometric (BMI, fat mass, active mass, Body height and weight) and functional parameters (heart rate, blood pressure and QRX max amplitude at rest after load). Correlation and regression analysis technique use to find out results. For statistically significant result they considered difference at the level of less than 0.05. after conducting the test, results show that Fat mass increased up to 2.30%, Heart rate decrease at rest, QRS max decreased, relationship

between Blood pressure and BMI/fat mass not conformed, Relationship between height and blood pressure found less obvious. Data confirmed significant ($p<0.05$) negative relationship between QRS at rest and body weight, BMI, fat mass and active body mass respectively and same result found between QRS after load and body weight ($p<0.01$), active body mass and BMI ($p<0.05$). linear relationship between Blood pressure ad body weight is less obvious with age. Relationship between Blood pressure and BMI/fat mass, has been not confirmed.

Opala-Berdzik, A. et al. (2021) conduct a study on Postural sway in young female artistic and acrobatic gymnasts according to training experience and anthropometric characteristics where Thirty 10–13-year-old subjects selected (artistic-10, acrobatic-10, non-athletes-10), Examined during 60-s quiet standing trials on a force platform with the eyes open and closed. Their postural way was represented by directional components of centre of foot pressure mean velocity. Mann Whitney U, Wilcoxon, and Spearman's ρ tests was used for analyses. Fallowing results found Anterior-posterior and medial-lateral centre of foot pressure mean velocities were not different between the artistic and acrobatic gymnasts ($p > 0.05$). In the artistic gymnasts, the duration of training experience, age, body height, body mass, and maturity offset were negatively correlated with the anterior-posterior centre of foot pressure mean velocity under eyes-open conditions. The acrobatic gymnasts' body mass and BMI percentiles were negatively correlated with their anterior-posterior and medial-lateral centre of foot pressure mean velocities under both visual conditions (r ranged from − 0.64 to − 0.93; $p <$ 0.05). The non-athletes' centre of foot pressure mean velocities were non-significantly correlated with their age and anthropometric measures under both visual conditions ($p > 0.05$). The artistic gymnasts' longer training experience, greater age, body height, body mass, and biological maturity were associated with better anterior-posterior postural steadiness when vision was available; the acrobatic gymnasts' greater body mass and BMI percentiles were associated with better overall postural steadiness regardless of visual conditions. Relationships were observed between postural steadiness and discipline-specific training experience and anthropometric characteristics; however, causes and effects were not proven.

Kaur kawaldeep et al. (2019) The study of Anthropometric Determinants of Competitive Performance in Gymnastics. Systematic review method included the data available without any limitation from the following databases; Google Scholar, Springer,

PubMed, Europe PMC, and research databases use for the study. search was done by using the key words: gymnasts, anthropometric profiles, somatic constitution, body composition, morphological models, growth and pubertal development, performance characteristics, level of performance. Studies with the following criteria were included: anthropometric values, profile or characteristics and somatic constitution, body composition, somatotypes and morphological models, growth, and pubertal development to determine the elements of the performance, factors influencing performance and the level of the performance. Seventy-six studies were identified and based on inclusion criteria 60 studies were excluded and only 16 studies were included in this study. After review they find the results appearance and aesthetic standards of body shape entail a better execution of gymnastics movements. Besides skills, training, motivation, psychological factors, physiological and biomechanical demands, numerous anthropometric compositions such as body size, body shape, and body type are responsible to contribute for the improvement of the performance of an athlete. The contribution of the age, height, body mass, circumferences and diameters however showed a significant result in all the Rhythmic, acrobatic, and aesthetic gymnasts. Gymnasts while in their developmental period induce training stresses on the cardiovascular and musculoskeletal system which involves changes in their body size and physiological characteristics side by side.

Atikovic et al. (2017) studied on morphological characteristics of 191 (Male Artistic gymnasts, n=94 and women Artistic Gymnasts, n=96) number of gymnasts who participated in Olympic Games 2016 in Rio de Janeiro, Brazil. The aim of the study was to determine whether there was a significant difference ($p < .05$) in the body weight and height between the male and female gymnasts. The result of the study found significant difference in height and weight between the groups. The average height of the male gymnast found 12.34 cm taller and in weight 14.75kg heavier than the Female gymnasts.

Bacciotti et al. (2017) studied (68 Sub-elite, 181 Non- elite) Brazilian female artistic gymnasts from 26 Brazilian gymnastics Clubs just to identify physique characteristics (Anthropometry, Somatotype and Body proportional). The age of the subjects was 9-20 years and divided into four age categories. Sub- elite and non-elite gymnasts were found similar anthropometric characteristics but non-elite group was significantly ($p < 0.01$) higher fat folds in all age categories. Generally, in all age categories the mesomorph was the salient somatotype

component and increase in endomorph and decrease in ectomorph. On the other hand, similar proportionality profile was found between non-elite and sub- elite with in age categories.

Joao and Filho (2015) Objectives of the study was to evaluate somatotype and Body composition of elite Brazilian national gymnasts in junior and senior level. Forty-six Brazilian gymnasts who have participated at list one time being the member of Brazilian team in the International Artistic gymnastics' competition since the year 2012. Total number of 25 male gymnasts aged 20.3 ± 3.41 years and 21 female gymnasts aged 17 ±4.66 years was the subject of the study. All the Anthropometric measurements were collected as per the guideline "International Society for the Advancement of Kin-anthropometry"(ISAK).

Kikuchi h. et al. (2014) The purpose of this study is to find out physical and physiological characteristics of top athletes in Aerobic Gymnastics. They tried to find out the characteristics for aerobic capacity and leg muscle strength of knee joint in the Aerobic Gymnastics world champions. Subjects where 3 world champions (2 males and 1 female) gymnast are selected for study. VO2 max was measured during bicycle ergo meter cycling, initial workload of 10W, increments of 18W/min (male) and 12W/min (female). And Isokinetic strength of knee extension and flexion were determined. Maximum isokinetic strength was investigated by measuring the peak torque for Continuous trials at the speed of 60deg/sec, 180deg/sec, and 300deg/sec by using a Biodex machine. After completion of test following results founds. Their numerical values were close to basketball players and synchronized swimming athletes and lower than long distance runners, skaters, and swimmers. These findings suggest that training for Aerobic Gymnastics is effective in increasing VO2max but it is influential in demonstrating an excellent performance of technical skill. The peak torque was decreased following the velocity increasing. Flexion/Extension ratios at 60 deg/sec of each athlete were 65.1% (W1), 44.1% (W2), 58.1% (W3) and at 300 deg/sec were 73.0% (W1), 67.6% (W2), 68.2% (W3). Their numerical values were lower than jumpers and sprinters in the track & field, especially that is marked difference in high velocity.

George et al. (2013) The purpose of this study was to investigate physiological characteristics of female and male Greek international artistic gymnasts during pre-competition

season. Nine female (mean age 16.89 ± 3.62 years, height 150.17 ± 7.06 cm, body mass 46.07 ± 9.26 kg) and eleven male (mean age 17.73 ± 1.55 years, height 161.18 ± 6.96 cm, body mass 58.09 ± 8.21 kg) international level artistic gymnasts recruited to participate in this study. They were evaluated for upper limps maximal muscular power, explosive strength of lower limp (vertical jump), maximal power of knee extensors and flexors, flexibility of hamstring and lower back, maximal oxygen consumption (VO2max), running speed at VO2max (vVO2 max), running speed at ventilatory threshold (VT), HRmax, maximal blood lactate concentration, maximal alactic leg power (Wingate test) and maximal leg frequency. Females mean %body fat was significantly greater compared with the males ($p<0.01$). Flexibility and VO2max was not different between females and male's gymnasts ($p>0.05$). On the contrary there was significant difference for female and male gymnasts on mean maximal blood lactate concentration, anaerobic alactic maximal leg power, maximal leg frequency, maximal explosive leg power (vertical jump), knee extensors and flexors power, shoulders flexors and arm extensors (bench press) maximal power, arm pulls, vVO2max, VT, and HRmax ($p<0.05$) The findings of the study was suggest that the physiological characteristics of international level gymnasts may play an important role during training. This provides coaches with valuable information on fitness parameters and helps to design individual training programs and evaluate responsiveness to training stimulus with the aim to maximize training adaptations and event specific performance.

Bester and Coetzee (2010) studied on anthropometric variables of South-African young female gymnasts who participated at junior and the senior level competitions were selected as the subject of the study. The subjects were divided into two groups as successful and less successful young female gymnast. Total twelve numbers (Age-13.39 ± 2.14) of subjects were taken for the said study. Sixty-one anthropometric variables of body were considered for the performance in vault event. The successful gymnasts found better than the less successful gymnasts in ankle circumferences, flexed and relaxed upper arm and mesomorph values. The findings concluded that larger upper arm and upper body circumferences; hand, foot, upper leg, triceps skinfolds, fat percentage as well as a higher ectomorph value are important anthropometric variables for vaulting performance. The conclusion of the study was drawn that the upper body circumferences; larger upper arm; hand, upper leg, foot, total leg lengths; fat percentage, triceps skinfold and higher ectomorph values were very much important variables for vaulting performance.

Heath &Carter's (1990) anthropometric method was use to evaluate the Somatotype. The fat percentage of male gymnast was found of 11.39 ±2.08 and for female 15.84 ± 3.79. The somatotype of the female gymnasts belonged 56 percent in Ectomorphic mesomorph, 25 percent in Endomorphic mesomorph, 13 percent Mesomorph-ectomorph and 6 percent in Ectomorphic mesomorph. On the other hand, the somatotype classification of male Artistic gymnasts belonged mainly three groups i.e., 48 percent in Balanced mesomorph, 33 percent in the Endomorphic mesomorph,19 percent in the Ectomorphic mesomorph.

CHAPTER III

METHODOLOGY

In this chapter the procedure adopts for selection of subjects, selection of variables, criterion measures, procedure of testing, collection of data and statistical technique employing for analysis of data is presented.

Selection of Subjects

For the purpose of this study, selection of subjects will be from upcoming Aerobics Gymnastics National championship. Total 90 Male Aerobic Gymnasts (45 from North zone and 45 from East Zone), age between 13 to 20 years will be selected from participating zone with the help of random sampling technique.

Selection of variables

The Following Variables will be selected to assess the Anthropometric, Physical and Physiological Variables of the subjects for the study.

A. Anthropometric Variables

- Standing Height
- Weight
- Arm length
- Leg length
- Shoulder circumference
- Chest circumference
- Arm circumference
- Thigh circumference

B. Physical Variable

- Speed
- Arms & Shoulder muscles power
- Abdominal Muscular endurance
- Leg power
- Trunk Flexibility
- Side splits

C. Physiological Variables

- Vital Capacity
- Fat %
- Resting Heart Rate

SELECTION OF VARIABLES, TEST & CRITERION MEASURES

Category	Variable	Testing Tools	Criterion Measure
Anthropometric	Height	Anthropometric rod	Centimeter's
	Weight	Weighing machine	Kilograms
	Length- Arm and Leg	Flexible steel tape	Centimeter's
	Circumference- Arm, Chest, Shoulder, and Thigh	Flexible steel tape	Centimeter's
Physiological	Vital capacity	Spirometer	Liters
	Fat %	BMI & Gallagher et al. (1996) equations	Percentage
	Resting Heart rate	Manually	Beat/min.
Physical	Speed	20 Meter Sprint	Seconds
	Arms & Shoulder muscles power	Push-up	Push-up in 30 sec.
	Abdominal Muscle power	Sit-up	Sit up in 30 sec.
	Explosive Leg strength	Standing broad jump	Meter
	Trunk Flexibility	Sit and reach test	Centimeter
	Side splits	FIG Physical ability test	Centimeter

Statistical Techniques

By selecting the level of significance at 0.05 level. For the analysing of data in the study following statistical techniques will be use.

- Descriptive statistics will be used for describing the data. In descriptive statistics like mean, skewness and kurtosis will be computed.
- Z- test use for analysing the data.
- SPSS software will used for calculation and computation of data.

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